510 J0

Manuscripts MS
5/15/34

THE USE OF GRAPHIC METHODS IN FOREST ENTOMOLOGY.

P.C. Johnson

The use of graphic methods to illustrate statistical data has received tremendous impetus in the past two decades. It has been convincingly demonstrated, both by educational means and by actual practice, that this method is far superior in most cases to tabular methods of presentation. Data presented in the latter form is too often passed over by the reader unless he is vitally interested, whereas a graphic illustration usually excites the reader's natural curiosity regardless of the subject.

Recognizing these facts, the various fields of commerce, education, engineering, and science have perfected the use of graphic methods of presentation and have developed distinct types of graphs to illustrate certain classes of statistics peculiar to their own needs. The forest insect field stations of the U. S. Bureau of Entomology have, in a similar manner, turned to this method of presenting much of the statistical data gathered in investigative and survey work in recent years. Several classes of statistical data recorded in forest entomology are also represented in economic and other branches of entomology, and these will be expressed below in graphic form.

Space does not permit a detailed analysis of the construction of graphs other than that shown in the examples to be given below. There are, however, certain well-established rules and procedure which must be followed and anyone not already acquainted with these should refer to one or more references (1, 2 and 3) on the subject before attempting to illustrate data graphically.

---

1. Board of Editors. Manual of Charting. Washington, D.C. 1923
2. Brinton, Willard C. Graphic Methods for Preserving Facts, New York, '14
3. Marshall, William C. Graphic Methods for Schools, Colleges, Statisticians, Engineers and Executives. New York, 1921

In presenting the following examples, a classification of the data will be made according to the type of subject, as follows:

1. The Quantitative presentation of Insect Losses.
2. The composition of insect population by species.
3. 3. Mortality of insects due to one or more Factors.
4. Life history diagrams.
5. Representative types of infested trees.

It is intended to give some idea of the type of graphs recommended for the above data and to show their proper construction.

The Quantitative Presentation of Insect Losses.

A large part of the activities of the forest insect field stations is the survey of commercial stands of timber to determine losses due to insects. Certain areas have been examined annually to check annual losses, the trends of the infestation and for the projection of losses in advance. Such information enables a control operation to be formulated at the proper time, ar at the beginning of an increasing epidemic, rather than during a decreasing one. It is an ideal situation for the use of the graphic method of presentation which is shown in Fig. 1. The data involved is quantitative in nature and is best shown by means of a bar diagram as illustrated. The bars should stand our prominently against the background of the graph, but not too much so. The unit of loss is monetary value in economic entomology.

The above data is presented in a different manner in Fig. 2, or by a point-to-point curve. This method is useful where a number of observations have occurred over a long period of time. The placing of the data of the three units close together in the same diagram facilitates comparison and reduces size and space required, but demands care in the selection of the vertical scale whose all three curves are in such close proximity to each other. While both graphs are self-explanatory, reference should be made of them in the text and the data expressed there in tabular form.

The Composition of Insect Population by Species.

Another type of information derived from forest insect surveys is the determination of the insect composition of the infestations. A continued series of such observations discloses the importance of each species of insect involved. Fig. 3a illustrates one of the best ways to illustrate this type of data where comparatively few observations have been recorded. This method consists of the comparison of component parts of a whole and may also be shown as in Fig. 3b. The latter style is inferior to that shown in Fig. 3a, since the visual comparison is not so evident and must be aided by the placing of the actual values opposite each component part.

In place of the above methods of expressing this type of information, the "pie" diagram and area or volume diagrams are often used. The former consists of a circle divided into sectors representing the component parts. The eye is not capable of measuring the area of each sector accurately enough for purposes of comparison and to compensate this disadvantage, this form must be accompanied by so much descriptive matter that its value as a graph is questionable.

The area and volume diagrams depend upon squares or cubes or various sizes to represent each component part. Again, as in the pie diagram, there is no convenient linear scale to assist the eye in forming an accurate comparison. Neither method has any place in scientific work of any kind and their use should be discouraged.

Mortality of Insects Due to One or More Factors.

In any branch of entomology where experimental brood studies are carried on, there is often need of recording the effects of two or more simultaneous factors acting upon the brood. Such data, while more difficult than the effect of only one factor, can very easily be shown graphically and is far more capable of digestion by the reader than the voluminous tables characteristic of this type of data. An example of this is illustrated by Fig. 4. In this case, one of the two vertical scales was placed at each end of the horizontal scale, though it is common practice to include both vertical scales on the left margin of the diagram. The use of two or more vertical scales calls for careful planning to reduce confusion to a minimum. The graph in Fig. 4 is really a summary of the results of a complete experiment and if properly constructed and labelled, could easily be shown with no accompanying text or tabular form.

Life History Diagrams.

Life history studies are one of the most common types of data used by entomologists and one peculiar to their own need. This data is invariably presented in graphic form and since there are no standards for their construction, with a few exceptions, hardly any two are alike.

To properly show the life stages of an insect having multiple and partial brooks is a difficult task. Simplicity should be one of the chief aims in the construction of life history diagrams. The simplest known method is some form of the bar diagram shown in Fig. 5. This is an example of an insect having several seasonal and partial broods. Guide lines aided by small arrows are a help in leading the reader through the various stages, but if these lines are so heavy as to cause any confusion by detracting from the bars, their purpose will have been defeated. Each stage of the development and each brood should be clearly labelled. Unlike the usual graphic form, the life history diagram begins in the upper left-hand corner with the overwintering stages and progresses chronologically, showing each distinct insect stage and each brood and ending in the lower right-hand corner with the overwintering brood. The time scale is usually shown by monthly or weekly divisions depending upon the rapidity of brood development.

Some life history diagrams have attempted to superpose artistic drawings of the insect specimens in their various stages and habitats upon a graphic framework. This often reduces the accuracy of the time element which is the primary feature of showing life history, and tends to introduce the habits of the insect upon the diagram. The latter should be left to the text. Such attempts to show more detail in the diagram, unless very cleverly done, too often results in producing a dewildering effect upon the reader and incurs too much wasted time in following the various steps.

Representative Types of Infested Trees.

The recent emergency conservation program of the U. S. Forest Service required the use of large numbers of inexperienced "spotters" for forest insect survey crews. As an aid in training these men for intelligent spotting work, diagrams similar to the one shown in Fig. 6 were developed by the U. S. Bureau of Entomology. The results of several years' experimental work was incorporated into a graphic form easily understood. It was furnished each man in convenient size and was the equivalent of several pages of descriptive material.

The use of graphic methods is to be encouraged in both technical and non-technical reports and publications in entomology. This field provides excellent opportunities for the presentation of much more statistical data in this matter than has been done in the past. With the ever-increasing amount of scientific information available it is becoming almost impossible to keep up with all new developments unless one keeps to an increasingly narrower field. The use of graphs to summarize important results will greatly aid in the assimilation of a much larger amount of data in a given time than would have been possible if all data were presented in tabular form.